Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

899

U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF EXPERIMENT STATIONS—BULLETIN NO. 171.

A. C. TRUE, Director.

REPORT

ON

AGRICULTURAL INVESTIGATIONS IN PORTO RICO, 1905.

LIBRARY
RECEIVED
JUL 23 1906
U. S. Department of Agriculture

BY

D. W. MAY, M. Agr.,

Special Agent in Charge, Porto Rico Agricultural Experiment Station.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1906.

U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF EXPERIMENT STATIONS—BULLETIN NO. 171.

A. C. TRUE, Director.

REPORT

ON

AGRICULTURAL INVESTIGATIONS IN PORTO RICO, 1905.

BY

D. W. MAY, M. AGR.,

Special Agent in Charge, Porto Rico Agricultural Experiment Station.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1906.

THE OFFICE OF EXPERIMENT STATIONS.

STAFF.

A. C. True, Ph. D., *Director.*
E. W. Allen, Ph. D., *Assistant Director and Editor of Experiment Station Record.*
W. H. Beal, A. B., M. E., *Chief of Editorial Division.*
W. H. Evans, Ph. D., *Chief of Division of Insular Stations.*
Elwood Mead, D. E., *Chief of Irrigation and Drainage Investigations.*
John Hamilton, B. S., M. S. A., *Farmers' Institute Specialist.*
Mrs. C. E. Johnston, *Chief Clerk.*

PORTO RICO AGRICULTURAL EXPERIMENT STATION.

D. W. May, M. Agr., *Special Agent in Charge and Animal Husbandman.*
W. V. Tower, B. S., *Entomologist and Plant Pathologist.*
H. C. Henricksen, B. Agr., *Horticulturist.*
J. W. van Leenhoff, *Coffee Expert.*
E. F. Curt, *Farm Superintendent.*

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Experiment Stations,
Washington, D. C., April 30, 1906.

Sir: I have the honor to transmit herewith and to recommend for publication as Bulletin No. 171 of this Office the Report on the Agricultural Investigations in Porto Rico for the fiscal year 1905, by D. W. May, M. Agr., Special Agent in Charge of the Porto Rico Agricultural Experiment Station.

Respectfully,

A. C. True,
Director.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

	Page.
Introduction	7
Coffee	8
Cane	9
Tobacco	11
Cotton	11
Corn	13
Rice	13
Potatoes	14
Forage crops	14
Fibers	17
Flowers	18
Live stock	18
Miscellaneous notes	20
Report of the entomologist and botanist	21
Investigations in entomology and plant pathology	22
Report of the horticulturist	23
Citrus fruits	24
The old method	24
The new method	25
Cultivating and fertilizing	26
Insect pests	27
Diseases	28
The present outlook	29
Pineapples	30
Vegetables	32
Mangoes	33
Avocados	34
Rubber	34
Miscellaneous plants	34
Report of the coffee specialist	42
Experiments with new plantings	44
Improvement of an old coffee grove	44
Diseases and insect pests	46

ILLUSTRATIONS.

		Page.
PLATE I.	View of a portion of the station plats, Mayaguez	16
II.	Fig. 1.—Cowpeas forty-nine days from seeding. Fig. 2.—Sisal plant two and one-half years old	16
III.	Fig. 1.—Saddle-bred stallion, Thornton McDonald 2237. Fig. 2.—Cabezona pineapples, showing method of planting	18
IV.	Fig. 1.—Mango tree two years from seed. Fig. 2.—Avocado two years from seed	34
V.	Fig. 1.—Castilloa rubber trees of same age in fertile loam and heavy clay soil. Fig. 2.—Well-filled branch of coffee	34
VI.	Fig. 1.—Coffee improvement; 2-year old tree produced over 2 pounds of coffee. Fig. 2.—Roselle (*Hibiscus sabdariffa*) in fruit	44
VII.	Fig. 1.—Coffee substation; road making in natural forest. Fig. 2.—Coffee substation; too heavy shade	44

REPORT ON AGRICULTURAL INVESTIGATIONS IN PORTO RICO, 1905.

INTRODUCTION.

The work of an agricultural experiment station in the Tropics is in many ways quite different from that of stations in the Temperate Zone. This seems peculiar, as it would appear at first glance that methods which are successful in the Temperate Zone would prove feasible in the Torrid Zone, but the conditions are so different that presupposed considerations are often in error. The growing season extends throughout the twelve months of the year, but there is quite a variation caused largely by rainfall and perhaps other causes that are not now known. Experimental work in the Tropics is almost altogether pioneer work, for in obtaining results methods worked out in other regions are of no avail and sometimes apt to prove misleading.

With the present knowledge of the methods of dissemination and control of yellow and malarial fevers there is destined to be at an early date a great forward movement in the production and resultant prosperity of the Tropics. Already there is a distinct immigration of northern peoples into this zone, and the returns from capital invested are becoming more and more remunerative. In furthering the interests of this region of the earth, bringing into it increased prosperity, there is no factor capable of doing so much good as agricultural experiment stations. The problems facing these stations are manifold; the questions before the investigator being so many and so varied he appears almost overwhelmed at the beginning of the work. With so many questions for solution it is readily apparent that the men and means available are wholly inadequate to the work in hand. In view of this condition the policy of the Porto Rico Experiment Station is to confine its efforts to a few lines and carry them to a successful issue before taking up others. In selecting lines of work it has sought to develop those productions and methods that with quick results will redound to the greatest good of the inhabitants of the island. It is necessary, therefore, that the first experiments be of a practical nature, leaving the more obscure problems for later consideration.

During the past year there has been a decided improvement in the agricultural conditions of the island. Some crops that have been

produced for many years are showing increased plantings, and several crops introduced since the American occupation are yielding a profit and are being extended. While the area of Porto Rico is comparatively small, the climatic conditions, due largely to rainfall, are quite variable. This will result in the predominance of some crops in certain localities. The conformation of the land also has somewhat to do with this matter. At present all low grounds that are at all adapted are devoted to the growing of sugar cane. It will be necessary later to rotate crops on these lands in some systematic way. In such case it is probable rice will be the main crop together with some legume.

COFFEE.

The interior is still and will continue to be largely devoted to coffee growing. Although the prices have not been favorable to the production of this crop, they are growing better, and when the American palate learns to appreciate the peculiar flavor of the Porto Rican berry it is probable that the price will be further enhanced. As will be seen by the report of the expert in charge, the experiment station is carrying on extensive experiments with coffee. These experiments are along several lines as introducing those coffees that bring the highest prices in the States markets, and also increasing the yield and improving the quality of the native product. Some of our importations, as Java and other coffees, will bear their first crop during the year 1905. It will then be possible to determine the quality of these coffees when grown under Porto Rican conditions. We have demonstrated that both the yield and quality of the Porto Rican berry can be greatly improved by better cultural conditions. The average production per tree in Porto Rico is much under 1 pound, while some of the new trees in the station grounds that are just coming into bearing are producing over 2 pounds per tree. This has been brought about by selecting good seed for planting in seed beds and by setting in the field only the strongest and most vigorous plants; also by pruning and thoroughly cultivating the trees until they come into bearing.

Some of the introduced varieties have fruited this year, and it has been possible to test in a preliminary way the relative merits of some varieties of Philippine and Hawaiian coffee. These varieties are believed to be inferior to the Porto Rican varieties, but some choice Ceylon varieties retain their characteristic flavor when grown under Porto Rican conditions. This is considered very encouraging, as it seems to indicate the possibility of growing varieties that bring the highest prices in the world's market without loss of their peculiar flavor and other qualities. It is hoped that it will be possible to report on a number of high-class Mocha and Java coffees next year.

This investigation is awakening wide interest among the coffee planters who are adopting improved methods of culture. It has been

the custom formerly to take up wild plants growing in the woods, set them at the proper distance, roughly prune them with a machete, and give them little or no cultivation.

CANE.

Since the American occupation cane growing has undergone an entire revolution. American capital has come in and built large sugar mills or centrals, resulting in the abandonment of the many smaller mills which dotted the cane regions. The cane growers find it more profitable to sell their canes to the large centrals than to grind them in their small mills, often using oxen for power and boiling the juice in open kettles.

Some of the larger centrals are carrying on experiments in growing cane and they are very urgent that the station undertake experiments in this line. Some experiments with cane have been taken up by the station, but our limited funds prevent very extended work in this line. By cooperating with some of the larger plantations the station hopes to obtain some valuable results along certain lines in cane production. At the present time the greatest interest is in the methods of planting and the proper fertilization of this crop. The fertilization of Porto Rican soils is very important as it has not had much attention in the past, and it is not known just what these soils most need. The results of preliminary tests indicate that cane responds very readily to commercial fertilizers, and while no very definite conclusions can be drawn at this time it seems that fertilizers containing the three elements—nitrogen, potash, and phosphoric acid—are advisable. On the ground of the station potash showed especially favorable results.

In buying fertilizers in Porto Rico planters are urged to buy high-grade goods. It is of course the nitrogen, potash, and phosphoric acid that constitute the value of a fertilizer and, owing to the high freight rates, there is no advantage in transporting an excess of filler in the goods. The last legislature of Porto Rico passed an act, prepared by the experiment station, providing for the inspection of fertilizers sold in the island. This forms a guaranty enabling the planter to protect himself in the purchase of fertilizers, and at the same time the printed label enables him to follow more closely the composition and the results of its use.

The station is securing some of the more promising seedling canes with the object of introducing these, after trial, upon the plantations. As in the case of many of the other economic plants of Porto Rico there is great need of breeding up the varieties of cane now grown. The centrals have been purchasing canes upon gross weight and are now discriminating in price only with varieties. With the economies that are coming in sugar production in Porto Rico they will shortly estimate the value by the sugar content, therefore improvement in cane

production must proceed along several lines. Not only must the gross yield be increased but the percentage of sugar in the juice must be raised. Again, it is observed that some varieties are more resistant to certain insect pests and fungus diseases. One well-known variety that has been grown in Porto Rico for many years is now being abandoned because of insect depredations toward which other varieties are resistant.

At this writing no very serious insect pests or diseases are prevalent in the cane fields, although with the largely increased plantings and lack of rotation such are likely to occur. Some such outbreak came about thirty years ago, when cane growing in Porto Rico was passing through one of the more prosperous periods of its history. Lately some diseased canes were brought to the station that were infested with larvæ of a species of Sphenophorus. The person on whose plantation it was found said the cane presented much the same appearance as during the serious trouble in the seventies.

The moth borer (*Diatræa saccharalis* Fab.) has been reported as doing damage in various sections. It is advised that cane seed be soaked for twenty-four hours in limewater before planting to destroy this pest and also as a hindrance to other troubles that might be present in the seed. This practice is also believed to favor the germination of the seed.

A further experiment has been made along this line to test the influence of several solutions on the germination and early growth of canes. Less than 5 per cent solutions were made up of lime, magnesia, lime and magnesia, ammonia, nitrate of soda and a mixture of nitrate of soda, acid superphosphate and muriate of potash. The canes soaked sixteen hours in a solution of lime and magnesia germinated quickest and made the best early growth. That soaked in limewater was next in thriftiness. The canes soaked in the ammonia water germinated second best but in a short time fell behind. Those soaked in the other solutions were slower in starting and less thrifty than those in the check plat, which were not soaked at all.

Besides the growing of cane the station has taken up some problems in the utilization of the by-products of cane. At present a great many oxen are used on the plantations, and as more and more land is being broken and planted the feeding of these animals is becoming a serious question. During the grinding season cane tops are fed in large amounts to the oxen and it seems possible that a way may be found for preserving these for future use. As a dry feed they do not seem to be relished, but it is probable that some means may be found for properly ensiling them. With these and other by-products of cane production and manufacture, like molasses, it is not improbable that in the future not only the work animals but large numbers of beef

cattle will be fed in the neighborhood of the centrals. At present the molasses is shipped to the States and incorporated in specially prepared stock feeds.

TOBACCO.

During the year the station issued a bulletin (No. 5) on Tobacco Investigations in Porto Rico. This includes a description of tobacco soils and methods now followed in growing tobacco in Porto Rico. Experiments in growing, curing, and fermenting tobacco are described in detail, and suggestions made for the improvement of our tobaccos both in culture and fermentation and in seed improvement. Our tobacco expert resigned to enter the Bureau of Plant Industry of the U. S. Department of Agriculture, and since that time no work has been carried on with the cigar tobacco growing in the interior. It is very necessary that further studies be made with this important crop, should our means allow. The tobacco soils of the island should be mapped out and further studies made of their fertilization. Researches with the curing and fermenting of cigar tobaccos are very much needed.

Some of the larger companies located in the interior valleys are producing a very fine quality of tobacco, both filler and wrapper. The soils of the station and their proximity to the sea forbid the production of the finer qualities of cigar tobaccos. Experiments are being carried out, however, in the production of other kinds used in manufacturing. It has been found that the White Burley, such as is grown in Kentucky, does very well on the soils of the station, producing a very large fine plant. Further experiments are being carried out with this variety.

COTTON.

There has been quite an increase in the area devoted to sea-island cotton in Porto Rico. This has been fostered by the experiment station, which distributed several tons of improved seed to various sections. The special agent in charge has also prepared during the present year a circular on cotton growing, which has been distributed over the island.

The quality of the cotton grown in Porto Rico is very good and it is a crop that is especially adapted to the country, because the poorer farmers can produce it in limited amounts without the aid of capital and employ their families in the various operations in its production. There is no boll weevil in Porto Rico, and the only insect pests reported as in any way seriously affecting the crop are the cotton caterpillar (*Alabama argillacea* Hbn.) and the cotton stainer (*Dysdercus suturellus* H.-Schf.). The cotton caterpillar has caused serious

damage in a great many fields. Although this insect has been on the island as far back as records go, it does not become a serious pest until the extended plantings of cotton permit it to increase in unusual numbers. It is found all through the Southern States, and since effective measures have been developed to combat it its depredations are not serious. It is highly important that our planters keep on hand a certain amount of Paris green unless in a position to obtain it quickly. This caterpillar marches like an army and, unless stopped, it will very rapidly devastate a field. It has appeared twice at the experiment station, but was readily checked by the use of Paris green mixed with lime, 1 part of the former to 8 parts of the latter dusted on the plants.

The experiments with cotton at the station have been somewhat extensive, following several lines. Two varieties of sea-island cotton are on trial and quite a number of Egyptian cottons procured from the United States Department of Agriculture, Bureau of Plant Industry. So far indications point to the sea-island cotton as the most profitable for Porto Rican conditions. The Egyptian cottons at the station have made a very rank growth, but the production has not been as good as expected, due doubtless to the excessive rainfall. These varieties will probably do better in the drier sections, especially where irrigation is practiced.

Our experiments with fertilizers indicate that the three elements of plant food are needed in Porto Rican soils, but more especially potash and phosphoric acid. With the first crop on most soils not much fertilizer is recommended, but it is advisable to use a little containing nitrogen, phosphoric acid, and potash. This will in all probability prove remunerative, will tend to interest the planter in the needs of his soil, and will start him in properly using fertilizers upon which the success of Porto Rican agriculture so much depends.

It is proposed to issue a bulletin on growing this important crop, and it is hoped that the area now planted will be extended in the island. It is estimated that during the year there were between 6,000 and 7,000 acres planted to sea-island cotton and that the yield will exceed 5,000 bales.

There is no especially discouraging feature to cotton growing in Porto Rico. The cotton caterpillar has caused losses, but as it is easily combated the planter should not become discouraged. It is probable that this insect will decrease the cotton acreage during the season of 1906 and perhaps for several seasons.

There is much to be desired in cotton culture in Porto Rico. Better methods of culture must be followed in order to improve the quality of the fiber. This should begin with the selection of the seed and end only with the delivery of the lint to the gin. Improved seed only should be planted, and all wild cotton destroyed to avoid contamina-

tion of the seed produced. Better culture must be given our cotton and it must be fertilized. Old cotton plants must be destroyed and not allowed to grow into a tree. Such cotton is inferior and the yields are too small. Because cotton grows naturally in Porto Rico the industry must not be given over wholly to nature.

CORN.

Some corn is grown in certain sections of Porto Rico, but its production should be greatly extended. The native varieties especially need improvement, as they are small, with large cobs and inferior grains. The station has been experimenting with corn from seeds grown in the States and also in improving the native varieties; so far our results with seeds from the States have not been promising. There is some peculiar condition here that prevents such corn from properly developing. This reason has not yet been determined, but it is hoped that some way will be found to utilize the improved varieties from the United States. In the meantime the station is endeavoring to develop an improved corn from native seed. Doubtless in time a very fine variety will be obtained, but could corn from the States be grown here that result would be reached much quicker.

The only serious insect pest on the corn plant is the cotton bollworm (*Heliothis obsoleta* Fab.), which attacks it during most seasons of the year. This is especially bad in regions of the greatest rainfall. It is rather hard to combat this insect, and planters as a rule in corn-growing sections plant at those times when the insect is less numerous.

RICE.

Porto Rico imports annually large quantities of rice, which constitutes a large part of the food of the people. By far the larger amount comes from the port of New Orleans and consists of the cheaper grades of the Louisiana rice. At the present time small patches of upland rice are grown, but there is practically none of the lowland rice. It will be necessary to introduce rotations on those fields devoted to cane, and rice will probably prove the most profitable crop to use in such a rotation. Those fields that are now well fitted for irrigation can be very readily devoted to rice growing. But to grow rice successfully in Porto Rico in competition with other countries, it will be necessary to use machinery as in Louisiana.

Although labor is plentiful and cheap, it can not compete with machinery in the production of this staple. The experiment station is growing rice in an experimental way under irrigation, and so far the indications are that this crop can be very successfully produced in Porto Rico. It is practically a new industry and it will probably be several years before it will assume the position that its impor-

tance warrants. At present the plantings of upland rice consist of small patches about the cabins of the poorer classes, who harvest the grain with the sickle and pound it out with hand mills.

POTATOES.

During the past winter (1904–05) a number of experiments were carried out in growing potatoes from northern-grown seed; five varieties in all were tested, the best results being obtained from Bliss Triumph and Early Rose. The yields were fair and the quality very good. The only serious pest developed was a blight which was kept in check with Bordeaux mixture. Some of the potatoes produced were shipped to San Juan and New York. As Porto Rico imports large quantities of potatoes every year, it is probable that prices will be better on the island during all seasons except late winter, when it may be profitable to ship to the States. During the coming winter (1905–06) several acres will be planted to potatoes, and shipments will be made to the principal cities of the island and to New York. The experiments made during the past winter indicate that under proper conditions potatoes may be grown successfully in a commercial way in Porto Rico. It is not thought that the section represented by the experiment station is favorable to this crop, owing to the heavy nature of the soil and the excessive rainfall. It is probable that the higher altitudes are better suited to the potato. There are no serious hindrances to growing potatoes that are peculiar to Porto Rico while the local demand is good and constant, large amounts of the tubers being imported annually from Spain and the United States. In growing potatoes in the island, however, the planter is advised to fertilize heavily and to spray often with Bordeaux mixture.

FORAGE CROPS.

The principal forage crops of the island are malojillo grass and Guinea grass, the former growing on low ground and the latter on the foothills. These are both very nutritious grasses, but they make heavy draughts on the soil, and the primitive methods of cutting and feeding by hand are expensive and crude. It would be far better for the soil if leguminous forage crops were grown instead of these grasses. The sterile and inhospitable condition of many soils is often due to the repeated removal of these grasses from the land. Fields are sometimes kept in cane from three to six years and are then allowed to grow up in malojillo grass. This grass is then cut for a number of years and sold off the land. Such a system of agriculture must ultimately result in a very poor physical condition of the soil. Even with the application of large amounts of commercial fertilizers they lose much of their usual effectiveness because the physical condition of the soil is so poor.

The station has a series of plats laid off for testing various legumes and other forage crops. (Pl. I.) Of the legumes the cowpea is the most promising. Quite a number of varieties have been planted and all do well when the soils are inoculated. The earlier varieties produced ripe seed in seventy days. The only serious pest of this crop is the leaf hopper, which cuts a good many holes in the leaves, but not enough to damage the plant greatly. The rainfall in the vicinity of the station is very heavy, and soils for cowpeas should be fairly well drained. In some of the drier sections it is probable this crop will do even better than at the station. In general the cowpea in its growth does not materially differ from the same plant in the States, except that the stem is somewhat thicker. A number of varieties have been planted throughout the twelve months, and while all seasons are favorable to their growth, they do better in regions of heavy rainfall if planted during the drier months.

This legume is one of the finest soil renovators known, not only storing large amounts of nitrogen in the soil, but leaving the ground in fine physical condition. It has been reported as doing well in the north side of the island among the orange groves. Any section growing cowpeas may have no fear of failure in improving the condition of its soil. The growth of this legume is one of the most promising developments of Porto Rican agriculture. (Pl. II, fig. 1.)

The beggar weed makes a fair growth, but does not reach the height it does on the light sandy soils of Florida. It will, perhaps, do better on the lighter soils of Porto Rico. In sandy soil on the north side of the island it has made a very rank growth. It is somewhat damaged by the same leaf hopper that troubles the cowpea.

Velvet beans do well on the station grounds and do not seem to be seriously damaged by insect or fungus pests. They do not make a rank growth on the heavy clay soils at the station, and for a quick growing crop are not equal to the cowpea.

Alfalfa on soil properly drained and inoculated is a very promising crop. The plat sown to this is now in full blossom three months from seeding, and it is the best the writer has seen anywhere at that age. Further observation will be necessary, but at the present it appears to be a very promising crop for Porto Rico under proper conditions. So far no insect or fungus pests have developed. This crop has been sown on a piece of well-drained land near the river, which is largely composed of clay and rather heavy for alfalfa. Our experiments on heavy clay upland soils have resulted in failure.

So far red clover, Japan clover, and Genge clover have not done well, but further trials are advisable. Clover sown in the Tropics should follow some hoed crop, and the ground should be fertilized with barnyard manure in order to get a quick stand. There are certain rank-growing grasses that spring up so quickly that there is a tendency for

them to choke out the clovers unless conditions for the germination and quick growth of the latter are favorable.

Two varieties of Phaseolus from India have grown well on wet soils and in wet weather. They are not equal to cowpeas and it is not advisable to grow them where the cowpea is well suited. The same may be said of certain navy and other beans which may be grown for fertilizing the soil.

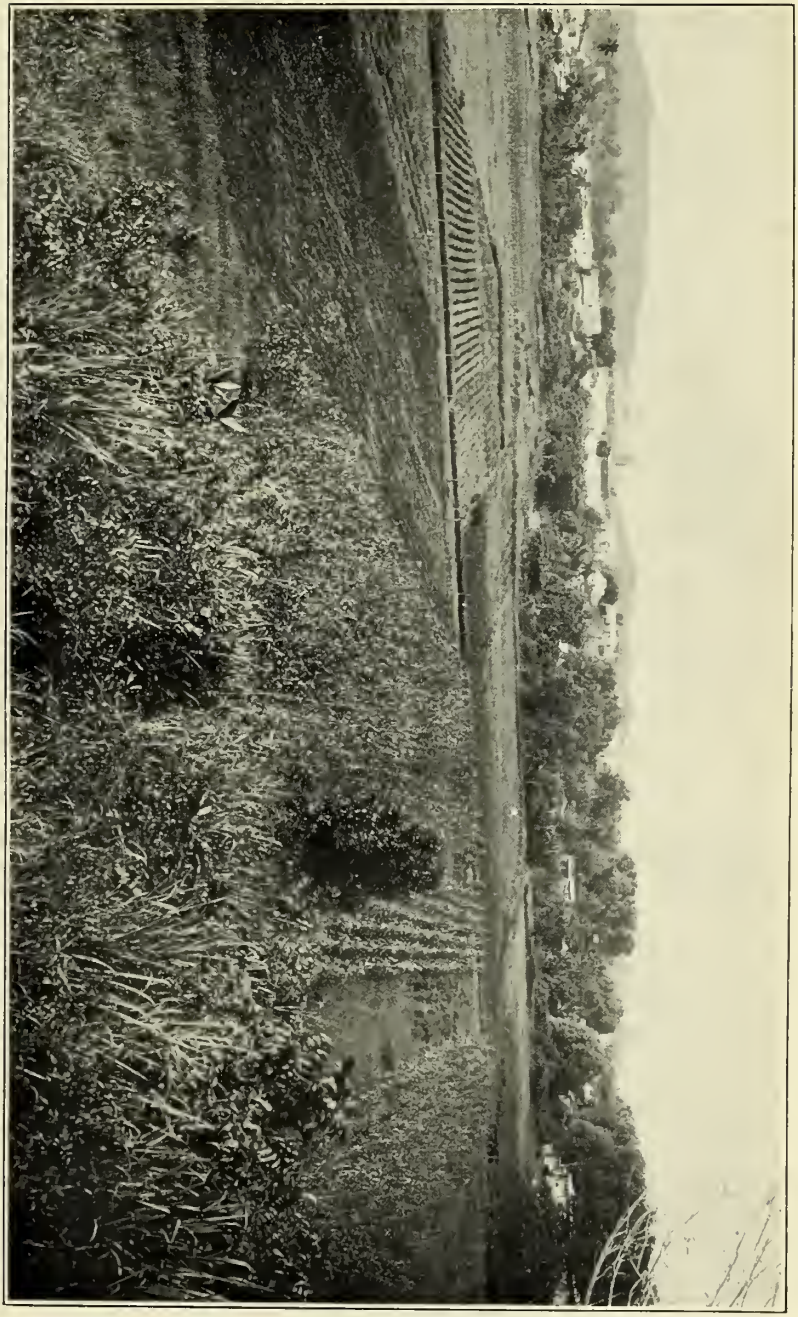
All varieties of lupines and vetches have failed to make satisfactory growth. They germinate but do not grow higher than a few inches. Lupines will blossom at about 5 inches high but make no further growth.

In testing legumes in a section new to them conclusions can not be drawn from a few trials only. Given suitable conditions, the legumes adapt themselves better to the Tropics than most any other plants. The matter of inoculating the soil with the proper nitrifying bacteria is one point that often marks the line between success and failure. Again, there is a question of acclimatization that must be solved. In general it seems advisable to repeat trials of legumes on the same ground, one trial after another, until the question of adaptability is thoroughly tested.

Sunflowers, like some other plants of the Temperate Zone, make a very quick but stunted growth. This striking difference in the growth in the Tropics is very peculiar with a number of plants and it is difficult to understand. Sweet corn, for example, sometimes makes a growth of about 2 feet in fertile soil, bearing tassel, and apparently going through all the stages of maturing. The natural conditions, as far as we are able to determine, are very similar to those under which the plants will flourish in the Temperate Zone, and at present no reason can be found that will explain this peculiarity. It is probably due to some factor connected with the soil.

Some experiments are under way with sugar beets and roots of fair size have been obtained. The sugar content has not yet been determined. The plant is very subject to blight in the later stages of growth. While the sugar beet can not compete with cane in the production of sugar in the Tropics, yet it might find a place in agriculture under certain circumstances; for instance, on the south side of the island some soils are so alkaline that no cane can be grown upon them. In cooperation with one of the plantations containing such soils an effort is being made to grow sugar beets, hoping thereby to remove the alkali with the crop of beets, so that ultimately cane may be grown. The beets can be put through the mill and yield a profit from the beginning, provided, of course, the sugar content is somewhat near that of beets grown in temperate regions.

Turnips and kale have also been grown in the experimental plats, and they do very well. These will doubtless prove of some value as an additional forage plant in the rations of live stock.



VIEW OF A PORTION OF THE STATION PLATS, MAYAGUEZ.

FIG. 1.—COWPEAS FORTY-NINE DAYS FROM SEEDING.

FIG. 2.—SISAL PLANT TWO AND ONE-HALF YEARS OLD.

Peanuts are grown in all sections of Porto Rico, the sole variety being the small red Spanish. Improved peanuts from the States have been planted and have been found to do as well as the Spanish variety in the experimental grounds of the station, and seed produced from these have upon replanting given equally favorable results. The high food value of this plant being well known, together with the fact that it is a nitrogen gatherer, its planting is recommended for all sections of the island.

Horse beans have made only a stunted growth of some 12 inches in height and have flowered; so far in our experiments they are classed as a failure. A number of other forage plants have been tested, but at this time no report can be made; some experiments have not gone far enough and others have failed for the reason of nongermination of seed. It is found that seed deteriorate very rapidly in this climate, probably on account of the great variation in the humidity of the atmosphere between day and night.

FIBERS.

Experiments with fiber crops as reported last year are being continued, with one or two additions. Indian hemp (*Cannabis sativa*) has been tested, but made a very poor and stunted growth. Of the other fiber crops that have been under test, sisal seems to be the most promising from a financial point of view. Maguey grows luxuriantly and is native to the island, but the yield of fiber is small compared with sisal. Sansevieria will make a good growth on certain soils, but the yield of fiber is much below sisal, and the soils that will grow this crop will also grow more profitable crops, like sugar cane. On high ground that plant makes a very meager growth. The insular government has decided upon taking up the growing of sisal on a commercial footing, setting 100,000 plants under the direction and supervision of the experiment station. The fiber expert of the Bureau of Plant Industry, U. S. Department of Agriculture, Mr. Lyster H. Dewey, made a visit to the island in the summer and looked into the fiber situation in different sections. He recommended that a commercial trial be made with sisal as the most promising of the several fiber crops tested by the experiment station. Upon his return to the States, a box each of sisal and maguey were sent to Paterson, N. J., for extraction in the machines. Mr. Dewey returned samples of these fibers extracted. Commenting upon that from the sisal, he writes as follows:

> This fiber is softer and more grayish in color than most of the sisal on the market, owing chiefly to the fact that it is from leaves only 2½ years old, while practically all of the commercial sisal fiber is obtained from leaves at least 4 years old. This fiber, however, is of remarkably good strength (Pl. II, fig. 2).
>
> We tried the maguey leaves in the machine at Paterson, but the machine would not clean them in a manner at all satisfactory. The fiber of the Porto Rican maguey is weaker than that of sisal and the leaves are less firm in texture.

FLOWERS.

There are many very pretty flowers native to Porto Rico, and with a little care homes may be made quite beautiful with them. There is a lack of systematic planting, however, and much to be desired in improving the quality of the plants. Roses especially do very well in this section of the island.

The native roses are small and not well adapted to use as cut flowers. The station has introduced many roses from the States, all of which do well, especially the climbers. Noisette or tender climbing roses like the Marechal Niel grow very rapidly and produce many very large, handsome flowers.

The dahlia makes a very rank growth and under proper treatment will produce very fine bloom. Hollyhocks grow and blossom readily. Cannas and caladiums are native, found wild, and lend themselves very readily to improvement. Geraniums grow very slowly and bloom sparingly. So far they can not be said to be a success. Lobelia and pansies have been grown in shady locations with much care, but they are not very vigorous. Carnations make a spindling growth and inferior bloom. Sweet peas indicate that success will be attained under proper methods of growing; some trials have failed utterly, and others have produced a small amount of nice flowers. Begonias do well; salvia only fairly well. Many other ornamentals are under trial and will be reported upon later.

LIVE STOCK.

The station has purchased from farm receipts a stallion registered in the American Saddle Horse Breeders' Association (Pl. III, fig. 1). It is very much desired that the quality of the Porto Rican horses be improved, as they have very seriously deteriorated. At present they are small and a great many unsound. Several importations of horses have been made into the island, and in the writer's opinion the lighter breeds, like the standard bred American trotting horse and the saddle stock that has sprung from the thoroughbred, are better adapted to Porto Rican conditions. One importation of 20 head of Norman horses, made by a sugar company, has not turned out very well, a number of them having been lost. These heavy draft horses unlike those of lighter breed, can not withstand the warm climate. Quite a number of mules are now being imported by the sugar planters and are supplanting the oxen on the plantations. Mules do very well where properly handled. The station owns 5, which have been on the island from two to five years. The native mules are small and used only in the interior as pack animals; they will not do for work on the cane plantations.

FIG. 1.—SADDLE-BRED STALLION, THORNTON MCDONALD 2237.

FIG. 2.—CABEZONA PINEAPPLES, SHOWING METHOD OF PLANTING.

Some cattle have been imported during the year, and from results it is probable there will be more brought in from year to year. The native cattle will doubtless lend themselves very readily to improvement, needing especially to be bettered in the line of early maturity and milk production. As work cattle they are very fair, and considering the lack of care in breeding they are remarkably good.

Porto Rico is infested with one of the cattle ticks, *Boophilus australis*, and it is necessary that imported cattle be inoculated either before or immediately after landing to prevent them from contracting tick fever. Two shipments of inoculated cattle made during the present year have done very well. The three head that were left at the station for a time apparently showed no signs of tick fever. A later importation of cattle is now at the station undergoing inoculation against this disease. There is a belief among some stockmen that tick fever does not prevail upon the island, but the Bureau of Animal Industry of the U. S. Deparment of Agriculture has received ticks from Porto Rico and has infested cattle in the States with them, bringing on the disease. The station is further testing this question in cooperation with the Missouri Station, and until definite instructions to the contrary are given all cattle coming to the island should be inoculated unless they come from below the quarantine line.

Some sheep are raised in Porto Rico, but their condition can not be said to be thrifty. They lose a great part of their wool, and in the section of greatest rainfall are very liable to disease.

Goats are found all over the island and add much to the nourishment of the poorer people. The station is endeavoring to obtain imported milch goats of Swiss breeding for the improvement of this class of animals. A great many sections of the island, in the interior especially, are adapted to goat raising and to no other class of animals.

Several importations of swine have been made into Porto Rico and, as far as the writer's knowledge goes, all have done well. The native pig is of the razor-back type, and it does not seem advisable to try to improve it, but rather to substitute pure-bred stock. No hog cholera or swine plague prevails on the island so far as the writer's experience goes.

All classes of poultry thrive in Porto Rico, but the stock found at present is greatly in need of improvement. Chickens consist mainly of the game breed, and are small and active, but not well adapted to meat or egg production. Several importations have done well. Ducks thrive, and quite a number of turkeys and guineas are raised. There is a good local demand for poultry products, and there are no serious hindrances to the production.

MISCELLANEOUS NOTES.

At the last session of the legislature, the old Spanish station, consisting of 7 acres of land and a few buildings adjoining the Porto Rico Station, was turned over to the latter. This makes altogether 242 acres in the station farm. In the Tropics it takes more capital, labor, and teams to cultivate land than in the Temperate Zone. The growing season extends throughout the year, and there being no frost to clear the land, it quickly grows up to wild grasses when not tilled. For this reason only a portion of the station farm has been planted. The low grounds have all been tile drained and planted to various field crops and vegetables. The high grounds have been planted to fruits of various kinds, including citrus fruits, pineapples, etc., and also cotton, cassava, sweet potatoes, broom corn, and cane.

During the year Mr. O. W. Barrett, entomologist and botanist, resigned to enter the U. S. Department of Agriculture. It is hoped to fill this position at an early date, and also to add during the coming fiscal year a chemist to the staff, and to build a chemical laboratory. No appropriation was made by the insular legislature for the assistance of the experiment station and no outside funds have been received. The farm receipts have increased somewhat in amount, exceeding $1,000. Cooperative work has been carried on with the Bureau of Plant Industry and the Irrigation and Drainage Investigations of the Office of Experiment Stations. The station has cooperated with the insular authorities in the enforcement of a fertilizer law passed by the last session of the legislature, and also in the enforcement of a plant inspection law.

The needs of the station are very urgent, as the work is developing quite rapidly in several directions. It is very important that more time be spent among the plantations investigating various troubles and advising the planters. The station needs the services of an entomologist, but there is so much work to do in both entomology and plant pathology that it would be advisable to have a man to follow up each line of research. It is also highly important that a chemist take up the study of Porto Rican soils and the proper fertilization of the same. There is also very much need that the waters used for irrigation purposes be examined and analyses made of the deposits of guano found in the many caves of the island.

Two farmers' institutes were held during the year—one at Bayamon and one at Rio Piedras. It is hoped to hold more during the coming year in other sections. Many trips have been made through the island by different members of the station staff in visiting the plantations. It is very important that this work be extended, and it is believed to be one of the best means of reaching the planters and rendering assistance to them in their work.

During the past year besides the Annual Report for 1904 the station issued Circular No. 5, on Coffee Growing in Porto Rico; Bulletin No. 5, on Tobacco Growing in Porto Rico, and Bulletin No. 6, on Yautias or Taniers.

REPORT OF THE ENTOMOLOGIST AND BOTANIST.

By O. W. Barrett.

Following is a brief account of the various lines of work conducted by the entomologist and botanist, until the spring of 1905, when he severed his connection with the station.

The lines of work were more or less identical with those carried on in 1904. During July, August, and September attention was directed largely to the study of the coffee leaf-miner parasites and toward the general study of the fungus diseases of native crops. The various collections of native crops, like yams, yautias, etc., were harvested during December and January and replanted on a larger scale in January and February. Many specimens were added to the herbarium.

The banana collection was increased by the addition of the Cuban varieties, and so far as possible the eighty-five or more numbered sorts were classed into distinct types, which were mostly grouped in the permanent variety test plat in the alluvial soil between the station office and the river Yaguez. It was found necessary to allow about twelve groups or types to contain the said number of varieties. During the arrangement of this collection it was discovered that several native varieties, largely believed to be identical, were quite distinct as regards the fruit itself. It is hoped that this test plat of banana varieties from various tropical countries of the world will definitely decide the question of synonymy of the local names, as well as decide several questions in regard to the adaptability of certain types to the manufacture of banana flour, banana coffee, etc.

The yautia collection was increased by the addition of a few varieties from Panama and Central America. The present number of varieties under observation is about fifty. A bulletin[a] giving a general résumé of the subject, together with the results of fertilizer tests, analyses, and prospective uses of the tubers, which, so far as is known, is the first bulletin to be issued on this subject, has been published. The crop is believed to be the oldest one in the history of agriculture.

The cassava collection was enriched by the addition of a full set of the Colombian varieties, secured in Jamaica by Prof. P. H. Rolfs, of the Subtropical Laboratory of Miami, Fla. About fifty named sorts are now on the variety list.

---

[a] Porto Rico Expt. Sta. Bul. 6.

Roots of ramie (*Bœhmeria nivea*) were set in a moist location near the propagating house, where they rapidly attained a considerable height. The plat of cadillo (*Urena lobata*) attained 12 feet in height, and the plants were almost branchless on account of the thick stand which was allowed to grow from volunteers. Samples of this fiber were prepared both by retting and by the dry stripping process; though the strength is great, the interlacing of the separate fibers is prohibitive to their successful combing by machinery. The Bahama sisal and the native maguey plants continue to make a good growth, while the plants of the "Cocuisa" do not show a satisfactory growth.

On account of the large number of seeds and plants received in exchange from botanical stations in the West Indies and other tropical countries, it was decided to lay out a small botanic garden for the reception of those plants which did not properly belong either in the forest plat or in the fruit orchard. About fifty species of more or less economic importance were set in permanent positions in the coffee grove north of the station office; coffee trees were left for shade.

Experiments in the manufacture of starches and flours from various native roots and fruits were continued throughout the greater part of the year. Samples of these products were sent to the Bureau of Chemistry of the U. S. Department of Agriculture and to several food experts. Some of the results were decidedly promising. Work with the banana coffees was also begun, but not completed; the varieties of plantain gave the best results both for a well-flavored flour and for a coffee substitute. Several varieties of cassava, especially those having bright yellow roots, appear to be particularly adapted to the manufacture of a flour which can be used for nearly any purpose to which wheat flour is adapted. The distinctive flavors are fairly well retained if the sliced roots are dried at a low temperature. Several varieties of yautias, particularly those having pink or purplish tubers, produce attractive looking flours which retain the highly nutritious and delicately flavored properties of the fresh tubers.

INVESTIGATIONS IN ENTOMOLOGY AND PLANT PATHOLOGY.

A second parasite of the coffee leaf-miner (*Leucoptera coffeella* Stain.) was discovered working in the same leaf mines with the common *Chrysocharis livida* Ashm. This rare parasite, which seems to be strictly primary, has been determined by Dr. William H. Ashmead as *Zagrammosoma multilineata*, and was first described by him from the locust leaf Tineid (*Lithocolletis ornatella* Chambers) of Kansas. Samples of infested coffee leaves were requested to be sent in to the station from all sections of the island, and, contrary to expectations, the parasite *Chrysocharis livida* proved to be distributed throughout the island; hence the breeding experiments were discontinued. The action of the latter parasite at the experiment station grounds has

resulted in the almost complete destruction of the coffee leaf-miner, although one year previous each coffee plant at the station grounds carried on an average something like twenty-five larvæ of the leaf-miner. Unfortunately, the good results of the parasites' work were not so much in evidence in other sections of the island.

The several insects injurious to cotton were studied during the year and a large cotton plantation was visited in the vicinity of Aguadilla, where great damage by a caterpillar had been reported. It was found that although the cotton caterpillar (*Alabama argillacea* Hbn.) had been somewhat destructive in small areas through the plantation the pupæ were nearly all parasitized. *Chalcis annulata* Fab. was reared from a few pupæ which were obtained in the plantation.

Ten species of mosquito-eating dragon-flies were studied on the station grounds.

The principal fungus disease not mentioned in last year's report, which deserves much study and which should be carefully guarded against in all the orange plantations of the island, is the Florida leaf-spot fungus (*Colletotrichum glœosporioides*). This fungus appeared during the last year in the station's citrus nursery, especially on rough lemon stock. It had been previously noted in several districts of the island, and it is doubtful whether this disease, which appears to be recently introduced, can be checked in its spread over the island. The peculiar root rot of the roselle (*Hibiscus sabdariffa*) attacked a few of the plants of this species. It is said to be common throughout Florida, and it appears to be of bacterial origin.

The exchange of seeds and plants with other stations in the Tropics has become a very important part of the station's work.

REPORT OF THE HORTICULTURIST.

By H. C. Henricksen.

Horticulture is yet in its infancy here, and it has been found necessary to do much pioneer work of a practical nature in order to form a basis for more scientific work. This has been especially difficult on account of the unskilled help, which has made it necessary for the horticulturist to attend to practical details which could and properly should be left to the gardener. It is hoped that it may be possible to secure the services of a trained man within a short time.

The climatic conditions of Porto Rico are such that results can be obtained in much shorter time than is required in the Temperate Zone. This is especially true when experimenting with annuals, but even perennials yield quick results. While this is an advantage in time saved it must not be imagined that it is work saved; on the contrary, it often requires the work of three or four years condensed into one. On that account it has been found necessary to take up one line

of work and carry it through to a finish, or, as far as practicable, leaving other work in such shape that it can be developed at the first opportunity.

This year more than half the time was devoted to vegetable growing, on which subject a bulletin has been published. The experiments with pineapples are well forwarded and will be made the main subject for the coming year, after which the propagation of the mango and avocado should be far enough advanced to take the lead. Work on citrus culture has naturally required considerable time and no doubt will for a number of years, though with the addition of an entomologist and a plant pathologist to the station staff the horticultural side of this work will be reduced.

CITRUS FRUITS.

The growers who started orange groves in Porto Rico three to five years ago followed the methods prevailing in Florida and California, and the general results have been unsatisfactory, but the experience gained is invaluable. This report, giving a brief statement of the experiments at this station, as well as field notes obtained when visiting groves in all parts of the island, is intended to serve as a guide for the beginner, with the hope that it will carry him over many of the old pitfalls.

THE OLD METHOD.

In planting an orange tree by the usual method of trimming many of the roots and a corresponding number of branches and leaves, the tree is severely checked, especially if it is shipped some distance. If the weather is not very favorable the top is liable to die back more or less after planting, and it will be some time before the new growth starts. If the grove is exposed to high winds this new growth will be forced in one direction, giving the tree a lopsided appearance which is difficult to overcome. This is not the worst feature, however, but the high wind and hot sun retard the growth of the tree. If the tree is planted in uncultivated ground with just a hoed circle around and not well fertilized, which is often the case, the growth is sure to be anything but rapid. If, then, May beetles and the orange leaf-weevil begin to eat the foliage, which they often do, the tree will have made but little growth the first six months after planting.

The nursery trees are seldom entirely free from the purple scale, and as this pest increases rapidly, especially when the tree is not in a vigorous growing condition, the consequence is that, six to eight months after planting, the tree will be covered with scales before the grower realizes what to do. Spraying is the next thing; but a continuous spraying with mixtures strong enough to kill the purple scale is sure to cause injury to the half-starved, wind-swept, scale-sapped tree. If, after

spraying, the trees are not thoroughly worked and fertilized, they will soon be beyond recovery and stand as scarecrows for the would-be orange grove.

If, on the other hand, the trees are well cared for, new growth will start from close above the union. This, if trained and kept free from scale, will form the new tree, and the old scaly stub may well be cut off as soon as possible, as it seldom makes much growth and it always serves as a breeding and distributing place for scale. But after all the efforts of the grower about two years of labor and expense has been lost. Of course, this is the dark side of the situation, nevertheless it shows exactly the conditions as they appear in many of the first-planted groves.

THE NEW METHOD.

All of these obstacles can be overcome by using methods which readily suggest themselves to the observant grower. The first and certainly the most important factor is shade and wind protection. The land should be cleared, well worked, and the rows laid out, after which a row of bananas should alternate with each row of trees. In about six months the bananas will be large enough to afford protection.

Plants like the pigeon pea (native name, gandula) or castor bean may also serve as temporary protection, but the first named is undesirable, because it harbors insects like the may beetles and orange leaf-weevil and the other is subject to scale of various kinds. In planting bananas it should be remembered that this plant is a gross feeder and will rob the orange trees if not checked. In order to do this a deep furrow should be plowed on each side about 4 feet from the banana row, and this operation should be repeated at least three or four times a year. The banana suckers should be thinned out and not allowed to spread too far. The yield of fruit may be found to be of considerable value, and in four to five years the plants may be taken out or left in the soil for fertilizer. The holes for the orange tree should be dug not less than 2 feet deep and 3 to 4 feet in diameter. The top soil should be filled in in alternate layers with dry grass, manure, or any other available organic material, together with 1 to 2 pounds of commercial fertilizer, preferably in organic form like tankage, blood and bone, dried blood, or native guano mixed with tobacco stems. The fertilizer should be well mixed with the upper layers of soil. The trees may be planted by the old method, but much better success can be obtained by planting with a ball of earth.

If the nursery is well fertilized and cultivated, the budded tree will be large enough for transplanting eight to ten months from budding or fourteen to sixteen months from seed. The nursery tree should be trained to stake in order to make a straight trunk and made to branch when not over 3 feet high. The branching should be carefully attended

to because the early branches will, with this method, form the tree. When ready for transplanting, a trench should be dug around the tree at a distance of not less than 1½ feet from the trunk and deep enough to go below the lateral roots. The ball of earth inclosing the roots can be loosened by cutting the taproot with a spade. Two men will be able to lift the ball while the third slips a piece of burlap underneath. This may then be tied, so as to inclose the whole ball, which can be lifted onto a wagon and transported any distance without breaking. Of course this can be done only where the soil contains enough clay to prevent the ball from breaking.

The cost of this method of planting was ascertained at the grove of Graham & Co., Pueblo Viejo, but as the men were just being trained in it, it is probable that the figures can be reduced about 5 cents.

Cost of transplanting tree with ball of earth.

	Cents.
Digging hole 40 by 40 by 24 inches deep	3
Refilling holes and mixing soil with fertilizer	2
Digging tree with ball of earth 2½ to 3 feet in diameter	8
Carting one-half mile or less	3
Setting tree and watering	3
Total	19

This is probably 10 cents more expensive per tree than the old method, but it readily repays the extra cost, because when a clean tree is planted there will be but little spraying to do and at least one year's time is saved in the growth of the tree.

CULTIVATING AND FERTILIZING.

It has been the practice with many of the growers to leave the whole field in weeds and hoe a circle around each tree. This has not given the best results, because in hoeing the soil is not loosened and pulverized. In other groves the method of cultivating strips around the trees and leaving the middles uncultivated has been practiced. While this is an almost ideal way to enrich the soil if the middles are planted with legumes and plowed once or twice a year, it has not been wholly successful here, because any growth of grass or weeds serves as feeding and hiding places for the May beetle, orange leaf-weevil, and ants. It has been found necessary in many groves to keep the soil perfectly clean by going through it often with tools like disk and drag harrows and tooth cultivators. If this method is followed part of the year, it is not a good practice to let the weeds grow tall enough to necessitate the use of a turn plow, because that implement will destroy many roots and probably check the growth of the tree and lessen its vitality.

In fertilizing, most of the growers apply a small amount three to four times a year, which of course is good practice, but the amount is generally too small. This is an offhand statement, as no experiments have so far been made in fertilizing the orange trees in Porto Rico, but the groves which have received a large amount of fertilizer are certainly far ahead of those which have received less. As to the amount and kind of fertilizers, the question seems to be limited to how much the tree will take up. Large applications of nitrogen in organic forms have not so far been followed by die-back; in fact, die-back has not yet been observed on the island and there seems to be no danger on that point.

INSECT PESTS.

Numerous experiments for combating the chief diseases and insects have been conducted by the horticulturist as well as by individual orange growers throughout the last year. In order to fully describe these it would require more space than would be desirable in this report; furthermore, it is questionable whether it would be necessary. It is firmly believed by the horticulturist and by many of the growers that the present impediments to orange growing in Porto Rico are merely trifling troubles which can largely be overcome by intelligent planting and cultivation.

The purple scale (*Lepidosaphes beckii* Newm.).—In studying the problem of combating this pest it was found that on a few trees in the station orchard which were well protected from wind and sun the scale was kept in check by three species of fungi. An attempt was made to disseminate these through the grove, but it was not successful; evidently the conditions were unfavorable. Trees in natural groves, which are protected from wind and sun and where the air is uniformly moist, are always free from scale, and several attempts to distribute scale through such trees have always resulted in failures. Practically the same results have been obtained in other groves, although after a tree has become literally covered with scale the fungi can not be relied upon even when conditions are made favorable to their growth. It should therefore be the aim to plant the shade first, and to set no tree which is not perfectly free from scale.

The orange snow scale (*Chionaspis citri* Comst.) nearly always follows a severe attack of the purple scale. It is difficult to overcome, because the trees are at that stage not generally in condition to withstand concentrated sprays. It is improbable that this scale will cause much damage if the purple scale is kept in check.

The red scale (*Chrysomphalus ficus* Ashm.) has gained a foothold in some of the groves, but it has been causing but little damage so far.

The orange leaf-weevil (*Exophtalmus spengleri*) and allied species is causing considerable damage in groves which are not given clean cultivation. Experiments made to destroy these pests with poisons have

not yet been concluded. Arsenate of lead has given favorable results, but whether it is because of killing the insect or merely repelling it is not known yet. Clean culture, however, is the best remedy.

May beetles caused considerable damage in former years, but in groves which are now kept free from weeds they have almost disappeared. The greatest damage caused by these insects is by eating the foliage; it is also universally believed that the larvæ feed on the bark of the roots. It is questionable whether much damage is caused in that way, but unquestionable evidence has been found in a few instances.

The brown ant which was reported upon last year by the entomologist of this station is not causing much damage at present. It occasionally eats the young foliage, which causes no severe injury to a vigorous tree. It very seldom injures mature bark except close to the ground. The injury there is caused by the ants building galleries of earth upon the trunk for some distance, which softens the bark underneath and makes it easy to puncture. The ants may live in those galleries for some time without puncturing the bark, but if left undisturbed for a long time they usually do so. The greatest damage is caused to trees which are affected with "gumming;" in fact, trees over two or three years old are seldom seriously damaged unless affected with that trouble. The remedy for ants is, in the first place, clean culture, by which means the nests are continually disturbed except close to the tree. For killing all the ants in a nest, nothing is better than carbon bisulphid, but that can not be used close to the tree, neither can it be used successfully in loose soil except when the soil contains enough moisture to make it impervious to the fumes. Any soap or emulsion used for scale is also a successful remedy for ants. Whale-oil soap or resin soap may be used as thick as it can be made to flow through the galleries, and it can be made more effective by adding crude carbolic acid at the rate of one part to ten of the soap solution. This can be used close to the tree without injury.

DISEASES.

With our present knowledge this subject must be treated with some caution, since many symptoms are ascribed to diseases which as a matter of fact are caused by some physiological derangement.

"Gumming" or "gum disease" occurs very frequently in some groves. When appearing on the limbs or upper part of the trunk it resembles psorosis, a disease known as "tears," from the fact that the gum often oozes through the bark in single drops. When appearing on the trunk above the collar roots it resembles foot rot or *mal-di-gomma* in some respects, while it is wholly dissimilar in other respects. The symptoms are exudation of gum, bark becoming brown in spots, frequently extending all around the trunk, and a

watery, somewhat gummy substance under the bark which is without perceptible odor. The cambium layer or inner bark is not destroyed, and the tree is able to recuperate. The disease has in no case been observed to extend below the soil or on the main roots. It has been observed on sweet orange, lemon, grape fruit, and sour orange, although not often on the latter. This disease is often described as being of a bacterial origin and contagious. While it is no doubt safest to treat it as such, the indications are that the causes are physiological. It has been found on all classes of soil, but it is much more prevalent on the heavier soils than on those which consist mainly of sand. It is also frequently found in the rainy season, while in the dry season the trees have been known to overcome it entirely. It has been observed frequently on trees less than two years old and not so often on trees over three. It appears that an oversupply of moisture is the usual cause, and probably an oversupply of plant food tends to aggravate the disease.

Gum disease has often been confounded with the effect of an attack by ants, because ants usually follow and greatly aggravate the case. Several remedies have been tried, among which are tar and girdle paint, the latter made according to directions given in Circular No. 4 of this station. Both of these are good if the diseased bark is first cut away and the material painted over the open sore only. Cases have been observed where these mixtures were applied without removing the diseased bark, and the disease continued under the bark without interruption. Also where the mixtures were applied all around the trunk the effect would be the same as a tight bandage, which could be detected twelve to eighteen months after the application was made. A thick soap mixture containing about five parts of crude carbolic acid is now being used successfully. It covers the sores and acts as an antiseptic as well as a repellant for ants.

Leaf spot caused by a fungus (*Colletotrichum glœosporioides*) is found on the grape fruit in some groves, and these trees are also occasionally attacked by scab. Both of these can be checked with Bordeaux mixture or ammoniacal copper carbonate, but these mixtures should not be applied unless necessary, because they also kill the fungus parasites of the scale.

THE PRESENT OUTLOOK.

The question of growing an orange tree in Porto Rico so as to obtain the maximum result at minimum expense can be expressed with the one word "experience." Groves three to four years old, which have been intelligently treated, are looking very promising and some are bearing considerable fruit of good quality. As to the most desirable varieties it is impossible to state definitely at the present time. Grape fruit is extensively planted and is very vigor-

ous as well as prolific. The tangerine is also promising in that respect. The lemon also seems promising, and the Sicily varieties are being planted by some parties. Citron growing is very encouraging, the Corsica attaining a large size and good quality. It is not so well known as the other citrus fruits, and this station has therefore planted 200 trees in order to demonstrate the possibility of this industry.

PINEAPPLES.

The station pinery now contains twenty-six varieties, most of which will bear this year. All of the varieties are remarkably healthy and so far very vigorous. An attempt was made to fertilize some of the plats, but those experiments were discontinued because the conditions were such that the results would have been of little or no value. The experiments will be continued this year in a near-by field with a uniform soil which has not been cultivated for many years.

Two of the plats in the pinery have been planted with *Pithecolobium saman,* which are growing vigorously. Several new plats are being planted with various shade plants which will be allowed to grow until large enough to shade the ground before the pines are planted.

Large areas are now being planted to pines in various sections of the island, and it has already been demonstrated that pines can be grown successfully in several districts, although much land is undoubtedly being planted which will give but poor results. It is very difficult to determine whether a soil is fit for pineapple growing or not, the only reliable test being to cultivate a small area as a trial. It should not be forgotten, however, that soils vary very much within a short distance, and the success in one corner of a 50 to 100 acre plat is no criterion for the whole field. In land about which there may be any question it is always safest to work the soil up in beds 6 to 7 feet wide. The Red Spanish can be planted four rows 18 by 18 inches in beds 6½ feet wide and the Cabezonas three rows 24 by 24 inches in beds 6 feet wide. This leaves 1 foot on each side of the outside rows, and if the paths are left 6 feet wide and excavated 6 to 12 inches deep, the top of the beds will be 1 to 2 feet higher than the bottom of the path, which will give ample drainage. Under those conditions the pineapple plant will thrive where otherwise it would fail.

In the fall of 1903 about 2 acres were planted at Rincon with the variety Cabezona. Those plants were reported to be diseased, and the field was visited in April, 1903, at the owner's request. The plants were found to be of normal size, but the color of the leaves was of a light red to pure wax white, about 50 per cent being entirely devoid of chlorophyl and less than 15 per cent showing green, the rest red, green, and white mixed. The field was located near the ocean, but in

no way injured by salt water. The soil, which was a beach sand, had recently been cleared of its natural growth, consisting mainly of cocoanut, sea grape, coco plum, a few sour orange, and the usual tropical shore line plants. The top soil, which was of a very fine texture, almost dust like, was found to be only 18 to 24 inches deep underlaid with a hard formation of cemented sand particles. Moisture was present in an overabundance in the top stratum, indicating the imperviousness of the subsoil.

While it was fully believed that the physical condition of the soil was the chief cause of the trouble, the extreme white color of the leaves might indicate some chemical derangement, and experiments were started June 2 to demonstrate the effect of fertilizers. The field was divided into ten plats, of which No. 1 was planned to be drained with surface ditches, No. 4 received an application of native guano, No. 9 received iron sulphate, and No. 10 was left for check. The other six plats were fertilized with commercial fertilizer in various combinations, which was applied under the direction of the horticulturist, one plat also receiving a liberal amount of lime.

The field was again visited October 15 and it was found that the owner had failed to drain plat No. 1 as agreed. The plants in all the plats were practically unchanged in color, but 20 to 30 per cent were found to be rotting in the heart and the heart leaves falling out, leaving the outside whorls intact. This is often met with in water-soaked soil, and can sometimes be partly remedied by drainage and aerating. Unfortunately that part of this experiment was not carried out, but in all probability it would have been of no avail in this case. It is safe to say that the soil was physically unfit for pineapple growing.

The station pinery planted with Cabezonas in the fall of 1903 (Pl. III, fig. 2) yielded a crop which was far above the average for that variety in Porto Rico or in Florida. Fully 95 per cent of the plants bore fruit, none of which were much below 5 pounds and the majority ranged from 8 to 15 pounds. As the soil in which these were planted is essentially the same as the majority of upland soil in this vicinity, it would probably be safe to apply the following figures to a large field: Planted 24 by 24 inches in beds 6 feet wide, with paths 6 feet wide between, will give 5,445 plants per acre. Reckoning on a yield of 85 per cent of marketable fruit the first cutting, this would average 4,628 pines per acre. These pines grown at the station were experimented with in various ways, to demonstrate the keeping and shipping qualities. One barrel was packed May 5 and sent by coastwise boat to San Juan, where it was transferred to the steamship *Ponce*, which left that port May 9 for New York. A report blank was sent to the steward, asking him to open the barrel May 10 and remove one fruit every day and report on the condition. He reported as

follows: May 10, 1 fruit fit for use, others too green, quality first-class. May 11, still green, not ripe enough for table. May 12, cut two and found them in first-class condition. May 13, about the same as yesterday. May 14, had one for lunch, first-class condition, no decay. May 21, after leaving New York for return trip to San Juan served last pine, which was in good condition. This barrel was stored with the ship's vegetables, not in cold storage.

June 3 two large boxes and one barrel were packed with pines wrapped in paper and packed in excelsior. These were bought by a private party to take to the States, but did not reach the railroad station in time to go as planned. They were then taken back and placed in a storeroom, where one box and the barrel was closely covered with several thicknesses of tarpaulin, making it almost airtight and very hot, being in that respect similar to the hold of a ship. One box was left uncovered, making the condition similar to the hold when ventilated. June 12 the two boxes were unpacked and no difference could be detected in the covered and uncovered lot, except the first was much hotter to the touch than the other. Nearly all the fruit was well ripened and only one out of thirty-three was bruised. When cut open most of the fruit showed brownish spots, indicating decay, but it was impossible to find the entrance or connection of those spots with the surface of the fruit. The decay was not far enough progressed to seriously injure the quality, but it is evident that a short time longer would have been fatal. The fruit would have sold readily because the outside appearance was all that could be asked for, but the same difficulties in shipping Cabezonas from this end of the island have been reported by several parties, and this will be made one of the chief features of the coming season's work.

VEGETABLES.

The importance of vegetable growing was recognized by the early management of this station as evidenced by previous annual reports. The results of the former experiments, although largely negative, are not without interest, remembering that by making proper deductions a negative result is as valuable as a positive. The experiments conducted this past year were planned to determine if vegetables can be successfully grown in Porto Rico, and if not, why not. Plantings were made in May, July, September, and November, 1904, and January and March, 1905. All of the principal garden vegetables were planted in large enough quantities to make the results of practical value. A large number of varieties were tested and the principal diseases noted. Various places on the island have been visited by the horticulturist who has noted the growth and behavior of vegetables under different environments, and obtained numerous reports from practical growers. This has been fully treated in a bulletin of the station. Some of the

points which may be emphasized are: Most of the common garden vegetables can be grown successfully in most localities; vegetables can be planted any time of the year, with generally best success in the winter season. This is not so much on account of the difference in temperature as that the excessive rains in the summer make the cultivation difficult. In the drier localities splendid results are obtained by irrigation.

Although vegetable growing in the Tropics is in many respects similar to that in the Temperate Zone, some experience is necessary in order to make market gardening or truck farming a success.

The usual truck crops of the South can be profitably grown in Porto Rico for the northern market, some localities being more favorable than others for certain crops. But by knowing the requirements of the desired crop and choosing the right locality success is reasonably certain.

The diseases and insect pest are practically the same as those of the southern part of the United States.

MANGOES.

Mangoes have been experimented with in odd moments throughout the year, but on account of pressure of other work and lack of skilled help it has been impossible to devote much time to them. Large trees have been top budded, using various methods. It was found difficult to make a union and even more difficult to force the buds. Much valuable information has been obtained, however, as a guidance for further work.

Nineteen inarched trees have been received from the U. S. Department of Agriculture. Some of these were inarched into large trees and some into 2-year-old stock, after which they were planted in the orchard. The trees in the orchard, which are now 2 years old, from seed average 6½ feet high with a spread of 4½ feet. (Pl. IV, fig. 1.)

Ten thousand seeds were planted in a nursery this summer. These were brought in by boys and paid for at the rate of 50 cents per 1,000. A large percentage did not germinate. Those which did germinate were subject to a fungus disease which destroyed more than 50 per cent. One thousand seeds were soaked in a solution of copper sulphate (1 pound to 50 gallons water) for twelve hours and were then planted in a seed bed, which had formerly been used for a vegetable seed bed. Eighty to 90 per cent of the seeds germinated, but in less than two weeks the plants began to die off. Both the plants and the soil were sprayed with Bordeaux mixture every week, but very few plants survived. This disease is not destructive to plants after reaching the size of a lead pencil, and it does comparatively little damage in sandy soil free from vegetable matter. In Florida the trouble was overcome by

using pure sea sand in the germinating bed, which has also been found entirely satisfactory here, but the plants should not be transplanted until the wood is well matured. This seedling disease is very destructive and very few volunteer seedlings survive. There are certain places on the island, however, where seedlings are plentiful under the large trees, and there it would probably not be difficult to grow a nursery.

AVOCADOS.

The 2-year-old trees in the miscellaneous orchard average 11 feet high with a spread of 7 feet. (Pl. IV, fig. 2.) Fifty more have been planted and a nursery containing about 1,000 plants has been started.

RUBBER.

The condition of the rubber trees is very much as in the last report. The Central American rubber trees (*Castilloa elastica*) which have been planted three years in very rich soil are now 16 feet high with a spread of 12 feet (Pl. V, fig. 1), while the others planted in the usual heavy clay soil are only 4 to 6 feet high. Trees which were sent to Arecibo and Bayamon have made growth similar to the best of these when on cultivated and fertilized soil. Some of the trees in the station plantation have been fertilized with stable manure, without perceptible change in growth and the result so far is negative. The experiments have brought out the following facts which correspond with the experience of the horticulturist in Florida. The Castilloa succeeds best when not transplanted or when transplanted very young, so as not to disturb the roots. A tree six to twelve months old is severely stunted by transplanting. The methods of planting in sod and keeping a small circle clean around the trees has not proved successful, except in soil which would have grown any other tropical tree under the same conditions. *Hevea braziliensis* has made but slow growth. *Manihot glaziovii* has made a fairly good growth near San Juan, where a few trees are planted in a yard. It is of course cultivated and probably fertilized. Small seedlings in the station nursery have been attacked by the cassava bud-maggot, which, however, does not damage larger trees.

MISCELLANEOUS PLANTS.

The following report does not include all of the plants under experiment by the horticultural department. Many have been omitted because it was thought that the conditions under which they were planted and the care received afterwards were wholly unsuitable. The same may be said about some of those reported upon, because a field test made here can not be taken as a criterion for the whole island. The chief aim of these experiments is to secure data for a report upon plants which may be of economic interest. This will bring them to

FIG. 1.—MANGO TREE TWO YEARS FROM SEED.

FIG. 2.—AVOCADO TWO YEARS FROM SEED.

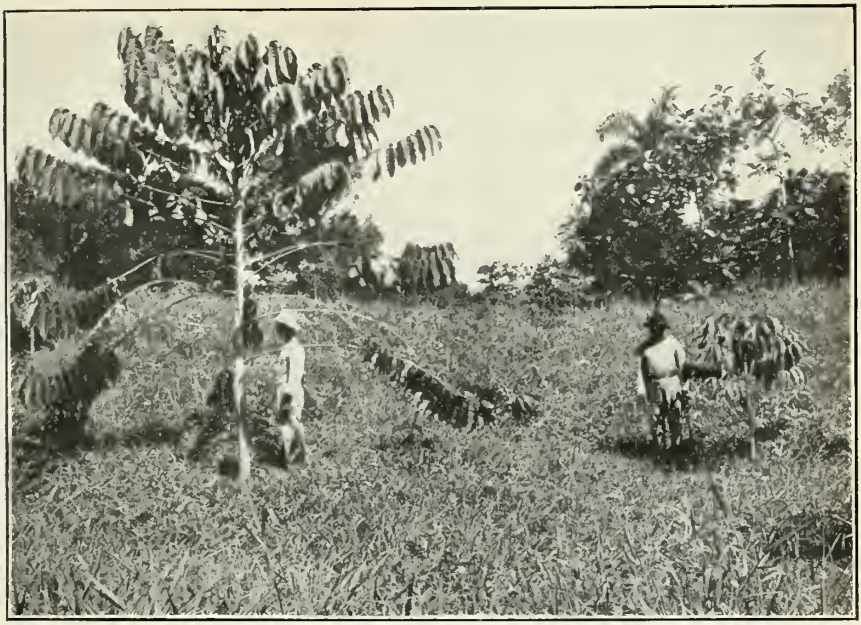


FIG. 1.—CASTILLOA RUBBER TREES OF SAME AGE IN FERTILE LOAM AND HEAVY CLAY SOIL.

FIG. 2.—WELL-FILLED BRANCH OF COFFEE.

the attention of the planters, a number of whom are always glad to cooperate with the station. After a plant has been tried in the various locations it will be possible to make an intelligent and full report.

Kei apple (*Aberia caffra*).—Planted small plants September, 1903; present height, 6 feet; spread, 7 feet; plants healthy; have not fruited, but elsewhere fruit reported to be of fair quality. Promising as a hedge plant for Porto Rico.

Sapodilla (*Achras sapota*).—This is commonly grown in Porto Rico, but it is of slow growth while young. Two-year-old plants in the orchard are only 2 feet high. It is a promising market fruit, and it can be grown successfully in the drier sections of the island.

Candlenut (*Aleuritis moluccana* and *A. cordata*).—The first mentioned is found more or less frequently on the island and is a fairly quick-growing tree. The latter was secured from the U. S. Department of Agriculture and planted in July, 1904. It is a tree of South Chinese origin and ought to thrive here, but it has been reported as a practical failure from all over the island. It would have been a valuable acquisition, as it yields an excellent lac varnish.

Cashew (*Anacardium occidentale*).—This is a tree commonly grown in Porto Rico. The fruit is edible and liked by the natives, but of questionable market value. Trees planted September, 1903, are now 7 feet high, with a spread of 5 feet.

Cherimoya (*Anona cherimolia*).—This is one of the best of all the anonas and highly prized for its luscious fruit. Small plants set in the orchard September, 1903, are now 6 feet high, with a spread of 6 feet.

The sweet sop, sour sop, and custard apple (*Anona squamosa*, *A. muricata*, and *A. reticulata*) are grown all over the island. *A. squamosa* is usually called cherimolia here, but the two should not be confounded, as they are quite distinct. Of the trees planted in the orchard two years since, the *A. muricata* is the most vigorous—height, 11 feet; spread, 5 feet.

Pond apple (*Anona glabra*).—Planted September, 1903; present height, 12 feet; spread, 11 feet; prolific bearer, but fruit of no commercial value.

Apple.—The Early Harvest and Red Astrachan varieties were received from Florida and planted March, 1905. Both have made satisfactory growth, although the leaves have been diseased.

Breadfruit (*Artocarpus* sp.).—Both the seed-bearing and seedless varieties are found all over the island. The trees are quick growing, but succeed best when not transplanted. The seedless variety is propagated from cuttings. Trees in orchard planted from cuttings October, 1903, are now 9 feet high, with a spread of 5 feet.

Jack fruit (*Artocarpus integrifolia*).—This is highly recommended from India and Ceylon. Several trees have been planted in the orchard and are growing vigorously.

Carambola (*Averrhoa carambola*).—Seeds were obtained from St. Lucia and seedlings planted in the orchard February, 1904. These are making very slow growth.

Arnotto (*Bixa orellana*).—This plant producing the annatto coloring has not been of commercial value of late years, but inquiries have been received lately from firms in the United States, and there seems to be a possibility for the product commercially. The trees grow readily here, and bear a good crop in eighteen to twenty-four months from planting. Trees planted in the orchard September, 1903, are now in bearing.

Tropical papaw (*Carica papaya*) grows to perfection in all parts of the island, but *C. quercifolia*, a more hardy species, has invariably failed.

Amatungula (*Carissa arduina*).—One plant of this spiny shrub was planted August, 1903, and is now bearing fruit. The fruit is of pink color, subacid, not unlike a small plum without the pit. It is well worth extensive planting for home use.

Divi-divi (*Cæsalpinia coriaria*).—This leguminous tree, the pods of which are rich in tannin, is making satisfactory growth, and it seems probable that it may be of commercial importance in Porto Rico, if planted in large enough quantities.

Tea (*Camellia thea*).—None of the four varieties planted in July, 1903, has so far made satisfactory growth. Plants have been distributed to other parts of the island, but it is yet too early to report on these.

Star apple (*Chrysophyllum cainito*).—Two varieties of this are commonly grown on the island. Both were planted in the orchard September, 1903, and the trees are now 7 feet high, with a spread of 7 feet. Although the fruit is of fair quality, it is not probable that it will become of commercial value.

Cocoa plum (*Chrysobolanus icaco*).—This is one of the common shore-line plants, which bears prolifically in the beach sand without any care. It is not dependent on that environment, however, as it grows readily in the orchard. The fruit is often used for preserves and the plant is an acquisition to the home garden.

Camphor (*Cinnamomum camphora*).—The camphor tree is not promising in this vicinity. Larger trees have been observed in sandy soil, but none that would indicate a profitable industry.

Cinnamon (*Cinnamomum cassia*).—The cinnamon of commerce is *C. zeylanicum*. This species is said to yield a good bark, however, and it seems to be promising here, one tree in the orchard being 11 feet high, with a spread of 7 feet.

Cocoanut (*Cocos nucifera*).—There are no large areas planted with cocoanuts in Porto Rico, but it is always present in the shore-line flora wherever the conditions are favorable. The cocoanuts of Porto Rico

rank among the best in the world's market, and although the industry is not so very extensive, it is of no mean importance to the island. No serious disease has been noted, and it is very important that the bacterial heart rot should not be introduced.

A disease was investigated in the summer of 1905 which appeared on the trunk as black spots, evidently caused by an outflow of sap. After splitting the trunk, these spots were found to extend about half way to the center and 6 to 8 inches vertically, with the softer portions decayed and the individual fibers exposed. Several spots would be found close together, but seldom connected. A small borer beetle, not determined, but probably a species of Xyleborus, was thought to be the primary cause, as a large number of those insects were entering the trunk of individual trees. Such trees first drop some leaves and then the fruit and the rest of the leaves, and finally die. The insect enters chiefly at a height of 6 to 8 feet. It is repelled by a coating of thick whitewash, and it would be well to whitewash the trunk of all the trees as high as practicable. Where the insects are numerous an addition of crude carbolic acid would probably be beneficial.

Akee (*Cupania sapida*).—Some trees in the orchard are vigorous and healthy, indicating that the tree can be grown here. The fruit is highly prized in Jamaica and Trinidad and it ought to be grown in Porto Rico for home use.

Turmeric (*Curcuma longa*).—This plant grows in most clay soils without the least care; in fact, it is one of the worst weeds in some localities. The root contains a yellow dye which has been largely replaced commercially by aniline dyes, but as there has been some inquiries about the plant lately it may possibly be of some importance.

Japan persimmon (*Diospyros kaki*).—The varieties, Hyakume, Hachy Okame, Tana-Nashi, and Yeddo-ichi were planted in April, 1905. The growth has not been satisfactory and the leaves are affected with some fungus disease. Trees have been observed on the north side of the island, in sandy soil, which were in no better condition.

Loquat (*Eriobotrya japonica*).—Some trees set in the orchard a few months only are making rapid growth, but as no large trees have been observed on the island it would be impossible to judge of its adaptability. It should always be planted in well-drained soil and not cultivated too deeply, as it is a surface feeder.

Rose apple (*Eugenia jambos*).—This is thoroughly at home here and can be grown all over the island.

Java plum (*Eugenia jambolana*).—One tree planted September, 1903, is now 5½ feet high with a spread of 4 feet.

Surinam cherry (*Eugenia mitchelii*).—This small bush, bearing a red cherry-like fruit, grows well in south Florida and will probably succeed well here. The two-year-old plants in the orchard have not yet borne fruit.

Otaheite apple (*Eugenia malaccensis*).—Two-year-old trees in the orchard are now 10 feet high with a spread of 6 feet.

Coca or Cocaine plant (*Erythroxylum coca*).—Plants have been tried repeatedly in the orchard, but they always bloom and bear fruit when a few inches high, after which they die. One bush 6 feet high, the usual size of the plant, has been observed in a yard in the city of Mayaguez, indicating that it can be grown here under favorable conditions.

Fig (*Ficus carica*).—Many varieties have been tried at the station, but all have failed. No fig tree has yet been observed in Porto Rico to indicate that figs can be grown successfully. Experiments are under way to graft onto *F. oppositifolia* and *F. glomerata*, which, if successful, will make a more vigorous plant. A leaf disease occurring uniformly on all the fig trees observed here can probably be kept in check with Bordeaux mixture.

Mangosteen (*Garcinia mangostana*).—This fruit, considered by many to be the most delicious in the world, is now being experimented with at this station. The tree is of very slow growth while young and the plants at the station are small yet. *G. indica*, an allied species to the *G. mangostana*, is growing in the orchard. Seeds were obtained in Trinidad, and the seedlings planted March, 1903. Present height, 4 feet; spread, 3 feet.

Genipap or Jagua (*Genipa americana*).—This grows wild in most parts of the island. The fruit is eaten by the natives, but not commonly by foreigners. It is of no commercial value.

Roselle (*Hibiscus sabdariffa*).—This plant, which is often called Jamaica sorrel, is becoming prominent as a jelly plant (Pl. VI, fig. 2). It can be successfully grown in all classes of soil, although a sandy loam is preferable. Two plats about one-eighth of an acre each were planted at this station in March. These plants began to ripen fruit in September and continued fruiting until December. One plat, on low ground which was flooded several times throughout the season, did not produce much fruit. Plants on well-drained soil produced 4 pounds of fruit per plant, averaging 2 pounds of calyx, the useful part. Plants observed at Pueblo Viejo, in sandy loam, were estimated to yield double that amount. To prepare the fruit the calyx should be separated from the seed capsules. The latter may be fed to hogs and goats. The seeds are also good poultry feed. The calyx can be made into jelly in the usual way, like cranberries, which the jelly resembles very much. It can also be boiled with an equal amount of water, squeezed through a colander, and filled into bottles, which may then be sterilized in hot water and corked for future use. Sugar and yeast may also be added to this, when it is said to make a very good substitute for root beer. The calyx can also be air-dried or dried in a fruit evaporator, in which condition it

will keep for a long time. The fresh fruit either with or without the seed capsule will keep for at least two weeks and may be shipped to the States in well-ventilated crates. It is firmly believed that this fruit will be of considerable value when introduced in the United States. The rich red color and acidity should make it a popular article for soda-water fountains. It would also be well adapted for mixing with other jelly fruits for color and acidity, where artificial preparations are forbidden or undesirable. The stems are reported to contain a fiber equal to jute. This has not been tested here, but it is well worth considering at the present price of fiber. This plant succeeds best when not transplanted, and it is therefore better to lay off rows 5 by 5 feet and drop a few seeds in each check. The seeds germinate quickly, but the first few months the plants do not grow very rapidly. After the plants are well developed all but one in each hill should be removed, and the soil should be kept clean until the growth makes cultivation impracticable.

Barbados cherry (*Malpighia glabra*).—This tree grows readily here and fruits at an early age. Two-year-old trees in the orchard are 5 feet high with a spread of 5 feet and bore fruit this year. The fruit is very good for jellies and desserts.

Mamme apple (*Mammea americana*).—This grows readily all over the island. Two-year-old trees in the orchard are 4½ feet high and well branched, from which it will be seen that it is not of rapid growth the first years. The fruit is eaten in jam by the natives and to some extent by foreigners. The tree is a prolific bearer, and if the fruit could be utilized commercially it would be of some importance to the island.

Spanish lime or Ginep (*Melicocoa bijuga*).—This grows readily here, although not very fast. The fruit is eaten, but it will probably never be of importance commercially.

Ceriman (*Monstera deliciosa*).—This aroid bearing a delicious fruit is not found in Porto Rico, but a few cuttings were recently distributed by the U. S. Department of Agriculture, and those received by this station are growing well. The plant succeeds best in a rather moist, half-shady situation, planted close to the trunk of a tree, or better, an old stump. These conditions can, of course, be found nearly anywhere in Porto Rico, and the plant is well worth extensive cultivation.

Banana (*Musa* sp.).—The botanical collection at the station comprises seventy varieties. The best of these are being planted in order to test them horticulturally.

Mulberry (*Morus alba*).—The three varieties, English, French, and Chinese, have been planted in the orchard a few months only, but the trees have made a growth of 7 to 9 feet in height and 4 to 6 feet in spread, the French being the more vigorous. One variety obtained on the island has been growing in the orchard for more than a year.

It is not as vigorous as the other three, but is very promising. Vigorous trees in other places have been observed, indicating the possibility of silk culture, which is actually being tried.

Downy myrtle (*Myrtus tomentosus*).—This is a shrub of Indian origin, bearing a very delicious fruit. One 2-year-old plant in the orchard bore fruit this year, and it can be thoroughly recommended for home use. It will probably not be a good shipper.

Nutmeg (*Myristica moschata*).—This is one of the species producing the nutmeg of commerce. One tree planted in the orchard September, 1903, is now 9 feet high with a spread of 7 feet.

Pear.—The varieties Le Conte and Keiffer were planted in April, 1905, the trees having made a fair growth.

Peach.—Six to twelve plants each of the following varieties were planted in the orchard in April, 1905: Angel, Bidwell Early, Bidwell Late, Jewel, Japan Dwarf Blood, Peen-To, Red Ceylon, and Waldo. These have made a growth of 6 feet high with a spread of 3 feet, as in the Bidwell Late, to 9 feet high with a spread of 6 feet, as in the Waldo and Red Ceylon. Six trees, comprising three different varieties, died early in the summer, from what was probably an overabundance of moisture at the roots, as it occurred in places not well drained. A fungus disease on the leaves has also caused some damage. Peach trees have been observed in other localities, but only a few planted in dooryards, and these were not very promising after the first year. Judging from the first year's growth, it seems probable that peaches may be produced here, but extensive planting can not be recommended until the termination of experiments now under way.

Plum.—The following varieties budded on Marianna stock were received from a Florida nursery and planted in April, 1905: Terrell, Excelsior, Red June, Abundance, Burbank, and Wickson. These have made a fair growth, the Excelsior being in the lead with a height of 8 feet and a spread of 6 feet.

Myrobolan (*Phyllanthus emblica*).—One plant in the orchard, set December, 1903, is now 16 feet high with a spread of 9 feet. It is a beautiful ornamental plant and the fruit is reported to be of fair quality.

Otaheite gooseberry (*Phyllanthus disticha*).—This tree is thoroughly at home here, two-year-old trees being 12 feet high with a spread of 10 feet and bearing fruit this season. It is valuable for dooryard planting, the tree being ornamental as well as very prolific, producing an abundance of acid fruit useful for preserves.

Guava (*Psidium* sp.).—The Porto Rican guavas are very inferior in quality and the fruit is usually attacked with a disease causing them to shrivel up and blacken when about half grown. The varieties introduced from Florida are seldom attacked and plants in the orchard produced magnificent fruit this year. The collection includes *Psid-*

ium guajava, P. molle, P. guineense, P. friedrichsthalianum, and *P. cattleyanum.* These species are represented by numerous varieties, all of which succeed well here except the cattleyanums, which are subject to the shrinking or mummy disease referred to above.

Mountain plum (*Rheedia edulis*).—This is a slow-growing tree related to the mangosteen. One plant in the orchard is making satisfactory, although slow, growth.

Tamarind (*Tamarindus indica*).—Both a sweet and an acid variety are found semi-wild in most parts of the island. Two-year-old trees in the orchard are now 7 feet high with a spread of 7 feet. It is not improbable that a market could be created in the United States for this fruit, and if so Porto Rico would be able to supply any reasonable demand. The tree succeeds well on the very driest portions of the island as well as where it is very wet, although it does not produce so much fruit in the latter localities.

Cacao (*Theobroma cacao*).—This is not produced in commercial quantities on the island, although a few trees are often grown for home use. Nine varieties from Trinidad, together with two commonly grown here, were planted in June, 1903, in a thickly forested valley. The natural growth has been cut out from time to time and cuttings of *Erythrina micropteryx* and *Gliricidia maculata* have been planted. The first named is far superior to the other; two-year-old trees from cuttings are now 15 feet high and well branched. The cacao is growing well, the trees being 5 to 10 feet high according to location. This method of planting is very successful and serves to illustrate the difference between this and the rubber reported upon (p. 34). In this case the natural growth was left and the soil is kept moist and in good condition, while in the valley where the rubber was planted the natural growth had been cleared off and the soil was in very poor condition for tree growth.

It may be mentioned that where the cacao is well shaded it is very healthy, while if the larger proportion of shade is suddenly removed the leaves die off and the tree is checked in growth.

Voa-vanga (*Vangueria edulis*).—Seeds were obtained in Trinidad and seedlings planted in the orchard in March, 1903. These trees are now 7 feet high with a spread of 8 feet. The fruit is reported as being worthy of cultivation, but ours have not yet fruited.

Vanilla (*Vanilla planifolia*).—This is not cultivated commercially in Porto Rico. A few plants have been reported from various places, but the writer has never had the opportunity to inspect them. In corresponding with persons who desire to plant vanilla the advice has always been given to be careful in importing cuttings, so as to avoid the introduction of the vanilla disease of some of the other West Indian islands.

REPORT OF THE COFFEE SPECIALIST.

By J. W. van Leenhoff.

The investigations with coffee have been continued under the agreement mentioned in previous reports.

In those parts of the Tropics where the climate is especially agreeable to the North American or European, coffee, as a rule, grows best. This condition prevails in a high degree in the mountain districts of Porto Rico; no finer climate can be found in the world. The temperature ranges between 60 to 85° F., and while during the rainy season, September to December, rain falls continuously up to 20 inches per month and the weather conditions are less pleasant, yet this is outweighed by the weather conditions of the eight remaining, and especially the first four, months of the year. The total rainfall for the year is 100 to 120 inches.

Coffee can be profitably grown on nearly all kinds of soils, provided they do not retain water. The mechanical conditions of the soil are to be considered before the chemical composition. Virgin forest soil is the best, and it can still be had at about $10 per acre.

Up to a few years ago the cultivation of coffee was generally conducted in a very primitive way. Since that time, however, the establishment of a coffee experiment station has brought about more modern practices—as, for example, the introduction of seed and nursery beds, which are now found everywhere in the important Ponce and Utuado coffee districts where a few years ago only volunteer plants were used.

There has been a pronounced improvement in the coffee industry of Porto Rico. The crop for the season of 1905 is much larger and there has been an appreciable advance in prices. The insular government has established a commercial agency in New York for the purpose of introducing the Porto Rican coffee to the best trade in the States and also to serve without cost as a selling agency for our planters.

A kind of bitter taste and, possibly, weaker strength were given as reasons preventing the introduction of our coffee into the markets of the United States at remunerative prices, as the first-class trade there is accustomed to the fine Java coffees. In those countries of Europe where a large and fine looking bean is appreciated, our first-grade coffee finds a good market. These markets demand a large, clean, green bean, polished and colored, which latter processing has caused much complaint in the United States.

The larger part of last year's crop of the experiment station sold at 13 cents per pound delivered in Ponce for shipment to European markets. Second grades were shipped in large quantities to Cuba at a

price of about 10½ cents per pound, this being due to the favorable tariff conditions with that country.

In order to obtain the highest prices for our coffee in the United States we must be able to compete with the fine grades of Java coffee, and with this end in view the coffee experiment station is now growing fine coffees from all parts of the world. Samples of these and the result of their crossbreeding will be sent to the United States market, and after due consideration of their different qualities, selections will be made and the planting of the selected varieties recommended to our coffee growers, and if possible seeds or seedlings will be placed at their disposal. At the same time, experiments are under way to increase the production per acre, which now averages about 350 pounds as against far larger outputs in other countries.

The interior of Porto Rico seems peculiarly adapted to producing the finer grades of coffee, and it would seem that those varieties that bring the top prices in the United States are the kinds toward which we should turn our attention. To grow such coffees would mean a very material increase in the prices received. In this connection the station is experimenting with different methods for increasing the yield and improving the quality of the product. This work is not only along the lines of better cultural methods, but tests methods of pruning, kinds and amounts of fertilizer, crossbreeding, etc.

The coffee experiments consist of: (1) Introduction of new varieties, of which groves of the following have been planted: Abeokuta from St. Lucia, Alta Verapaz from Guatemala, Haitian, Harrar from Abyssinia, hybrids from Ceylon, Kona from Hawaii, Liberia from Java, Maragogype from Java, Maragogype from Guatemala, Mauritius from Java, Menado from Celebes, Multiple Seed from Porto Rico, Padang from Sumatra, Philippinean, Preanger from Java, Robusta from Java, Stenophylla from Java. Although among the foregoing several desirable ones will probably be found, they represent only a small number of the varieties of the world. It is recommended that steps be taken to secure a complete collection of the different high-grade coffees of other countries, so as to be able to determine the best for Porto Rican conditions.

(2) Selection of varieties of desirable quality for the market of the United States and distribution and reproduction of same. Some of the introduced varieties will bear their first crop during the coming year, and it is hoped that in a short time it will be possible to determine their quality when grown in Porto Rican soil. As soon as desirable selections can be made, coffee seeds or plants will be distributed in various sections of the island among representative planters.

(3) Improvement of Porto Rican coffee by different methods of cultivation and by crossbreeding with other desirable varieties. Up to the present 2,269 Porto Rican trees have been planted in seventeen

fields. All the plants are doing well, and some of them will give first berries this year, but not sufficient to be able to show results or permit of selection for future use. However, enough has been determined to show the profitableness of improved cultural methods. Some of the trees coming into bearing are yielding over 2 pounds per tree (Pl. VI, fig. 1), which is several fold above the average of Porto Rican coffee.

As predicted in the former report the crop of 1904 was a poor one, not alone in the quality of berries harvested, but also in the weight of marketable coffee obtained from the berries. The heavy blossoming and favorable weather conditions of this year promise far better results for the present crop (Pl. V, fig. 2).

The experimental work has now approached the end of the constructive period. All the land necessary in the immediate future has been put under cultivation and according to the growth of the young plants different experiments can be taken in hand, while in the old groves the experiments thus far begun have been continued and should show results in the coming crop.

EXPERIMENTS WITH NEW PLANTINGS.

About 20 acres of virgin forest land have now been cleared and laid out in 51 fields, 34 of which are assigned to experiments with coffee and 17 to experiments with economic plants which may prove of value to coffee growers (Pl. VII, fig. 1).

The cost per acre of preparing the land, planting with coffee, and cultivation for one year was as follows:

Felling forest and burning	$11.00
Lining in, distances 7 by 7 feet	2.00
Making 888 plant holes 2 by 2 by 2 feet, at $10 per M	8.88
Filling of 888 plant holes, at $10 per M	8.88
Seeds and nursery beds for 888 plants ready for planting	5.00
Planting, transporting, etc., at $10 per M	8.88
Shade-tree seedlings and planting	1.50
Two hoeings, 1 foot radius in a circle around the tree, at $5 per M each.	8.88
Four weedings, at $1.50 per M each	5.32
Total cost of 888 plants, corresponding to 1 acre, at the end of first year	60.34

All figures given are for the locality of the substation, but may vary somewhat in other sections in the island.

IMPROVEMENT OF AN OLD COFFEE GROVE.

Experiments of previous years on the improvement of an old coffee grove was continued and the crop produced on each of the acre plats under experiment was again ascertained. The results, as shown by the crop of 1904, are as follows:

U. S. Dept. of Agr., Bul. 171, Office of Expt. Stations.

FIG. 1.—COFFEE IMPROVEMENT—2-YEAR-OLD TREE PRODUCED OVER 2 POUNDS OF COFFEE.

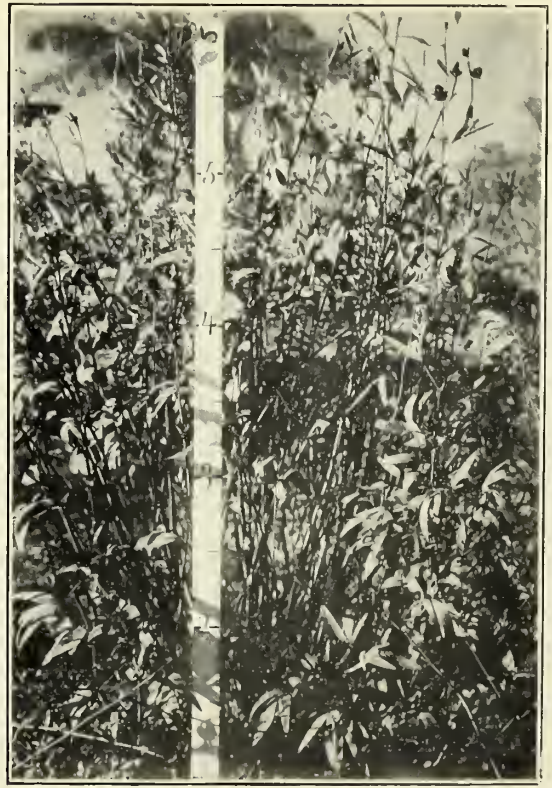


FIG. 2.—ROSELLE (HIBISCUS SABDARIFFA) IN FRUIT.

FIG. 1.—COFFEE SUBSTATION. ROAD MAKING IN NATURAL FOREST.

FIG. 2.—COFFEE SUBSTATION. TOO HEAVY SHADE.

Yield of coffee on experimental tract in 1904.

	Acre No.—									Total.	Average per acre.
	1.	2.	3.	4.	5.	6.	7.	9.	10.		
Ripe berries:											
In liters	738½	1,474	1,346½	904	83	113	93	137	41	4,930	547.7
In pounds	918½	1,892	1,756	1,195	114	148	126	188	61	6,398½	711
Coffee ready for market, in pounds	170	350	325	221 1/10	21 1/10	27 3/10	23 3/10	34 3/10	11 3/10	1,184	131.5
Productive trees per acre	413	1,095	882	742	428	745	584	902	924	6,715	746
Product per tree, in pounds	0.4116	0.32	0.3685	0.2979	0.0493	0.0366	0.04	0.0387	0.0122	1.5748	0.1755

Acre plats 1, 3, and 4 were divided into quarter-acre plats, each receiving different treatments. The yield of these plats is given in the following table:

Yield of coffee on quarter-acre plats.

Acre and plat.	Ripe berries.		Coffee ready for market.	Productive trees per plat.	Product per tree.
	Liters.	*Pounds.*	*Pounds.*	*Number.*	*Pounds.*
Acre No. 1:					
Plat No. 1	307	365.5	67.6	145	0.4662
Plat No. 2	291	376	69.6	104	.6692
Plat No. 3	140.5	177	32.8	85	.3859
Plat No. 4	0	0	0	79	.....
Acre No. 3:					
Plat No. 5	854	1,108	205	389	.527
Plat No. 6	492.5	648	120	173	.6936
Plat No. 9	(a)	(a)	(a)	191	(b)
Plat No. 10	(a)	(a)	(a)	129	(b)
Acre No. 4:					
Plat No. 7	437	565	104.6	258	.4054
Plat No. 8	47	68	12.6	114	.1106
Plat No. 11	243	328	60.7	140	.4336
Plat No. 12	177	234	43.2	230	.188
Total	2,989	3,869.5	716.1	2,037	3.8735
Average per plat	299	387	71.6	170	.3515

[a] All coffee trees cut on stump.

[b] Not yet productive.

Total berries harvested, 4,930 liters=246½ almudes, which have given 1,184 pounds coffee ready for market, or 4.8 pounds per almude.

The low percentage of marketable coffee obtained in 1904 from the berries resulted in an increase of about 20 cents per 100 pounds in the cost for picking, making the total cost of harvesting and marketing per 100 pounds, $2.46. The cost of weeding and pruning the plantation during the year was $6 per acre, or $51 for 8½ acres, making the cost per 100 pounds, $4.30. Total paid for labor per 100 pounds, $6.76. The coffee sold consisted of 998 pounds of first grade at $13.12½ per 100 pounds, and 186 pounds of second grade at $10 and $11 per 100 pounds, or an average price of $11.37½ per 100 pounds.

Some experiments with fertilizers and leguminous crops on the coffee have been made, but because of the heavy rains, as stated in the former report, no results have been obtained that are reliable.

Acre No. 2, containing 1,095 trees, was fertilized December 8, 1903, with 950 pounds Porto Rico bat guano, and produced 350 pounds, as against 206 pounds in 1903, or an increase of 144 pounds.

Acre No. 3, which is situated on the slope immediately below acre No. 2, produced 325 pounds, as against 243 pounds in 1903, an increase of 82 pounds.

These are the only acre plats that, notwithstanding the unfavorable weather conditions, showed an increase of production, which might be attributed to the application of the bat guano in acre No. 2 and the supplying of plant food from the same to the lower lying No. 3 by rain-water. Bat guano can be had nearly all over the island.

Harvesting began October 13, 1904, and lasted until February 28, 1905, during which time eight pickings at different intervals had to be made.

Contrary to expectations, the two shoots remaining on each stump, and which have now developed into fair-sized trees, did not blossom to any extent this year.

The aspects of the two plats, Nos. 9 and 10, have now changed—that is, while before the shoots in No. 9 without shade grew quicker than those in No. 10 where the shade was left, it is now exactly the contrary, and in No. 10 the shoots look much better than in No. 9.

Plat No. 14, replanted with 164 coffee seedlings and the existing old shade left, is doing very well and the trees are growing nicely.

Plat No. 16, replanted with 190 coffee seedlings and all shade removed, is not doing so well; some of the seedlings have slowly developed, but others do not seem to prosper in the full sun.

Both these plats are situated at the lowest altitude of the grounds, and several hundred feet lower than No. 2.

Plat No. 15, planted to alfalfa, was reseeded with inoculated alfalfa seed, which came up well, but since does not continue to grow. Inspection of the roots did not show any root tubercles, and as a whole the plat does not look so promising as last year.

DISEASES AND INSECT PESTS.

Scale (*Saissetia hemisphærica* Targ.) is not so abundant as in former years, which may be due to various parasites.

Leaf weevils have done considerable damage, eating the leaves and young twigs and in some instances even ruining the young trees. It was noticed that in the neighborhood of Higuerillo trees the weevils were most abundant. Hand picking in the adult stage was resorted to with apparent success. In some places in the old plantations the weevils also attacked the small green coffee berries, but apparently to no great extent.

Leaf miners (*Leucoptera coffeella* Stain.) have increased enormously, and especially in the young coffee up to about 4 feet high. In many

cases they were so abundant that the leaves died off, leaving the young coffee trees without any foliage whatever. In a neighboring plantation about 10 acres of young coffee trees are now almost entirely leafless. Hand picking has been tried, and in the month of May it was believed to have met with success, until a few weeks later a new and highly increased attack did away with all hopes to control the evil by hand picking. It is further observed that the better the soil the less the plants suffer from the attack. In the older plantations it seems that the parasites of the leaf miner, *Chrysocharis livida* Ashm., are sufficiently abundant to keep the evil under control. Artificial increase of the parasites might give very valuable results.

Some old coffee trees were observed on which the leaves had turned to a reddish color, followed by the trees dying. Leaves of such trees were sent to Washington for examination, where it was found to be a fungus, *Colletotrichum coffeanum*, probably appearing after an attack of leaf miner. The attacked trees had been already destroyed before information from Washington was received, and no remedies were tried.

In about 50 acres of heavily shaded old coffee (Pl. VII, fig. 2) near Juana Diaz a disease causing the kernels of the fruit to decay and turning the twigs black was found. Samples of attacked twigs and berries were also sent to Washington for investigation, but as yet the cause of the trouble is unknown.

O

U. S. DEPARTMENT OF AGRICULTURE
LIBRARY

NOTICE TO BORROWERS

Please return all books promptly after finishing your use of them, in order that they may be available for reference by other persons who need to use them.

Please do not lend to others the books and periodicals charged to you. Return them to the Library to be charged to the persons who wish them.

The mutilation, destruction, or theft of Library property is punishable by law. (20 Stat. 171, June 15, 1878.)

Lib. 9

GPO

3—7888